

**Remarks:**

Claims 2, 3, 5-14, 17 and 19-21 are pending in this application. Claims 2, 3, 17 and 19-22 are rejected. Claims 5-14 are withdrawn from consideration. Claim 22 was canceled and claim 21 was amended

**THE PRIOR ART REJECTION**

Claims 2, 3, 17, 19, 21 and 22 were rejected under 35 USC 103 as being unpatentable over Brupbacher et al (US Patent 5059490) in view Gottselig et al.(US 4,961,529) and further in view of Kugler (US 4,410 412).

For an obviousness rejection to be proper, the Patent Office must meet the burden of establishing a prima facie case of obviousness. **The Patent Office must meet the burden of establishing that all elements of the invention are disclosed in the cited publications, which must have a suggestion, teaching or motivation for one of ordinary skill in the art to modify a reference or combined references.**<sup>1</sup>

**The cited publications should explicitly provide a reasonable expectation of success, determined from the position of one of ordinary skill in the art at the time the invention was made.**<sup>2</sup>

**We didn't see that Examiner meet the burden of establishing that the cited publications have a suggestion, teaching or motivation for one of ordinary skill in the art to modify a reference or combined references and that the cited publications provide a reasonable expectation of success, determined from the position of one of ordinary skill in the art at the time the invention was made.**

It is an object of the present invention to provide particle-reinforced metal matrix composite materials comprising in-situ precipitated complex ceramic particles distributed throughout metal matrixes. The invention is suitable for the manufacture of flat or shaped titanium matrix composite articles having improved mechanical properties in applications such as lightweight plates and sheets for aircraft and automotive applications, heat-sinking lightweight electronic substrates, bulletproof structures for vests, partition walls and doors, as well as for sporting goods such as helmets, golf clubs, sole plates, crown plates, etc.

We agree with Examiner that Brupbacher's patent contains some hard particles mentioned in our original Application. The Examiner acknowledges that Brupbacher et al. does not disclose the presence of the complex carbide-silicide particles in the titanium matrix composite material

as recited in claim 21 on page 4 of the Office Action. For this reason, the Examiner has cited Gottseilig et al. to supply the missing teaching of Brupbacher et al.

We agree with the Examiner that Brupbacher et al. does not specify the presence of complex carbide-silicide particles in the titanium matrix composite material as claimed. The Gottseilig et al. (US 4,961,529) invention **concerns a method of welding together silicon carbide parts or brazing silicon carbide and metal parts together by means of a special bonding layer on a silicon carbide joint surface.** It includes the provision of a silicon carbide component having a joint surface prepared for brazing to a metal part.

We disagree with the Examiner, that it would have been obvious to one of ordinary skill in the art, that during the direct synthesis process of Brupbacher et al. (US Patent 5059490) the claimed  $Ti_3SiC_2$  would be formed in the presence of SiC and Ti as evidenced by Gottseilig et al. (US 4,961,529) (abstract). Gottseilig et al. (US 4,961,529) does not relate to titanium matrix composite in any way. The  $Ti_3SiC_2$  layer cannot be used for reinforcing titanium matrix composites. Both assertions are wrong.

It is not obvious that  $Ti_3SiC_2$  will be formed during sintering of SiC with Ti, and Examiner cannot scientifically prove the formation of the  $Ti_3SiC_2$  compound. Silicon carbide (SiC) is a very stable and inert material in the temperature range of conventional sintering processes used in the manufacture of titanium matrix composites. Therefore, as claimed in our invention, we prepare complex carbide particles, such as the above mentioned  $Ti_3SiC_2$  particles, and incorporate them into the powder mixture **BEFORE SINTERING.**

The Examiner acknowledges that the Brupbacher et al. and Gottseilig et al. does not disclose the presence of the intermetallic compound of  $Al_8V_5$  in the titanium matrix composite material as recited in claim 21 on page 4 of the Office Action. For this reason, the Examiner has cited Kugler to supply the missing teaching of Brupbacher et al. and Gottseilig et al.

The second reference to Kugler's Patent is irrelevant to our invention. **Kugler ( US 4,410 412) has no relevance to titanium matrix composites at all!**

The Kugler invention relates to **an exchangeable, solid cathode in an electrolytic cell for producing aluminum** via the fused salt electrolytic process. "An exchangeable, wettable solid cathode for a fused salt electrolytic cell for the production of aluminum is made out of at least one aluminide of the groups IV A, V A or VI A of the periodic system of elements. A titanium

aluminide of the .gamma.-phase has been shown to be particularly favorable for this purpose” (see Abstract of the Kugler’s invention).

Example 2 and claims of Kugler’s patent show electrodes made of separate aluminide compounds (zirconium aluminides, or molybdenum aluminide, or vanadium aluminides) that are not mixed between each other, nor are they mixed with carbides. Kugler’s example of  $ZrTiAl_5$  indicates that Kugler probably tested this complex aluminide compound individually. Even if we assume for the sake of argument that the latter example is obvious (we do not agree with this position) it does permit anyone to conclude that other combinations are obvious.

Claim 1 of the Kugler’s patent confirms this by asserting that the electrode is “...substantially entirely aluminide...”. There is not a word about composites made with titanium carbides.

In Kugler’s patent “In the fused salt electrolytic process for making aluminum it is known to employ wettable, solid cathodes. It has been proposed therefore to employ cathodes made of titanium diboride, titanium carbide, pyrolytic graphite, boron carbide and other substances, including mixtures of these substances which may have been sintered together.”(col.1, line 34-40) and “EXAMPLE 2. Cathode elements for the aluminum electrolytic process can be made from other aluminides in a manner similar to that used to make titanium aluminide cathodes. There is no reference to complex carbides or silicides.

**Neither of the prior art documents: Brupbacher et al. (US 5,059,490), Gottseilig et al. (US 4,961,529) contain aluminum-vanadium  $Al_8V_5$  hard particles incorporated into a titanium matrix as is claimed in our independent claim 21.**

We agree with the Examiner that the above-mentioned carbides, silicides, aluminides and other compounds can be formed in the matrix during sintering as the result of reactions between components of the initial powdered blend. But the fact that this formation occurred for Kugler in one example or another does not predetermine that it will occur in every instance. It is not obvious. These compounds may or may not be formed. It is impossible to completely control this process.

Therefore, we include such powders as  $Al_8V_5$  and  $TiCr_2$ , in ready form, in the basic blend. Under our process this blend is then subjected to compaction and sintering. In the prior art, these particles resulted from the chemical reaction during sintering and the prior art inventors cannot prove whether these particles will actually appear or not. Under our process these particles are

incorporated in predetermined amounts and with predetermined particle size. In other words, we control the effect of these dispersed particles on the mechanical properties of the resulting titanium matrix composite.

Intermetallic particles  $\text{Al}_8\text{V}_5$  play a very important role in hardening of the titanium matrix composite based on the Ti-6Al-4V matrix. The  $\text{Al}_8\text{V}_5$  particles have a composition that is chemically very close to the matrix alloy. Therefore, due to facilitated diffusion between said particles and the matrix alloy they form very strong chemical bonds with the matrix alloy grains during sintering. Thus, the  $\text{Al}_8\text{V}_5$  hard particles are the most effective structural strengthening component among other hard particles, and the presence of  $\text{Al}_8\text{V}_5$  hard particles is necessary in the invented titanium matrix composites.

Controlled uniform distribution of said particles in the matrix is possible only by incorporating them into the initial powdered blend before compaction and sintering of the final product. We prepare the  $\text{Al}_8\text{V}_5$  fine particles separately and mix them with titanium, other carbides, and silicides before sintering. Only this approach allowed us to improve mechanical characteristics of the targeted titanium composite.

The Examiner states that our Claims 2,3,17,19,21, and 22 are rejected under 35 U.S.C 103a as being unpatentable over Brupbacher et al. (US 5,059,490) in view of Cottselig et al. (US 4,961,529), and further in view of Kugler (US 4,410,412).

We agree that above mentioned three referred patents contain hard particles mentioned in our original Application. However, we would like to call the Examiner's attention to the fact that not one of the above referenced patents contains all of the components of our invented material together in complex.

The Examiner acknowledges that Brupbacher et al. does not disclose the presence of the complex carbide-silicide particles in the titanium matrix composite material as recited on pages 2 and 3 of the Office Action. For this reason, the Examiner has cited Gottseilig et al. and Kugler to supply the missing teaching of Brupbacher et al. Also, Brupbacher et al. does not specify the presence of the complex carbide-silicide particles in the titanium matrix composite material as claimed.

The Gottseilig et al. (US 4,961,529) invention concerns a method of joining together silicon carbide parts or brazing silicon carbide and metal parts together by means of a special bonding

layer on a silicon carbide joint surface. It includes the provision of a silicon carbide component having a joint surface prepared for brazing to a metal part.

The Gottseilig et al. (US 4,961,529) invention is about brazing silicon carbide parts by sintering  $\text{Ti}_3\text{SiC}_2$  particles to form a solid layer of  $\text{Ti}_3\text{SiC}_2$ . This means that Gottseilig et al. does not relate to titanium composite material and does not comprise other components of the invented titanium composite material disclosed in our Application.

In the Office Action the Examiner wrote (p. 3 and p. 4) that:

- (a) It would have been obvious to one of ordinary skill in the art that during the direct synthesis process of Brubacher et al. ('490) the claimed  $\text{Ti}_3\text{SiC}_2$  would be formed in the presence of SiC and Ti as evidenced by Gottselig et al. ('529) abstract, and
- (b) it would have been obvious to one of ordinary skill in the art to substitute the carbides (e.g., TiC) with the claimed  $\text{Al}_8\text{V}_5$  in the titanium matrix composite with an expectation of success, because the carbides and  $\text{Al}_8\text{V}_5$  are functionally equivalent as disclosed by Kluger (US Pa. 4410412, col. 1, lines 34-40 and Example 2).

In the present invention a fully-dense discontinuously-reinforced titanium matrix composite material comprises:

- (a) a matrix of titanium or titanium alloy as a major component,
- (b) ceramic and/or intermetallic hard particles dispersed in the matrix in the amount of 50% by volume or less include particles of  $\text{Al}_8\text{V}_5$  compound, and
- (c) complex carbide- and/or silicide particles that are at least partially soluble in the matrix at the sintering or forging temperatures such as  $\text{Ti}_4\text{Cr}_3\text{C}_6$ ,  $\text{Ti}_3\text{SiC}_2$ ,  $\text{Cr}_3\text{C}_2$ ,  $\text{Ti}_3\text{AlC}_2$ ,  $\text{Ti}_2\text{AlC}$ ,  $\text{Al}_4\text{C}_3$ ,  $\text{Al}_4\text{SiC}_4$ ,  $\text{Al}_4\text{Si}_2\text{C}_5$ ,  $\text{Al}_8\text{SiC}_7$ ,  $\text{V}_2\text{C}$ ,  $(\text{Ti},\text{V})\text{C}$ ,  $\text{VCr}_2\text{C}_2$ , and  $\text{V}_2\text{Cr}_4\text{C}_3$ ,

Neither one of prior art documents: Brubacher et al. (US 5,059,490), Gottseilig et al. (US 4,961,529) contain aluminum-vanadium  $\text{Al}_8\text{V}_5$  hard particles, which are incorporated into the titanium matrix according to our independent claim 21.

Summarizing the above discussion, we would like to say that the Examiner has used an incorrect approach to analyze our Application. Any one real alloy or metal composite material is characterized by the totality of components that provide target properties of the material. The Examiner brings different components from three different prior art materials. None of the referenced materials comprises all of our components. Moreover, two of the referenced materials patents, Gottselig et al. and Kugler, are not for titanium composites and do not even

comprise the main constituents of our invention. If the Examiner were to continue his approach to its logical conclusion, the result would be that no alloy or structural material could ever again be invented because all metal elements are well known in general from other alloys.

The independent claim 21 has been amended by this document. In view of all the foregoing comprehensive discussion and analysis, we respectfully submit amended independent claim 21, and claims 2, 3, 17 and 19 that are dependent upon amended claim 21. All as these claims can be clearly patentably distinguished from Brupbacher et al., Gottseilig et al., and Kugler, singly or in combination, under 35 USC 103.

Allowance of Claims 2, 3 and 17, 19, 21 is respectfully requested.

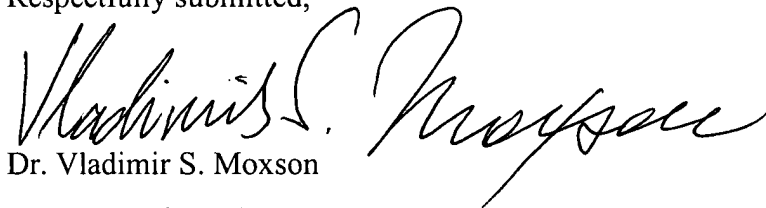
Should any questions arise, the Examiner is encouraged to contact the undersigned.

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Entry of this Amendment, allowance of the claims, and the passing of this application to issue are respectfully solicited.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned for prompt action.

Respectfully submitted,



Dr. Vladimir S. Moxson

ADMA Products, Inc.

1890 Georgetown Rd. Hudson, OH 44236

(330)650-0065